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VI*

**EXPEDITION OF THE CALIFORNIA ACADEMY OF
SCIENCES TO THE GULF OF CALI-
FORNIA IN 1921¹**

GEOLOGY AND PALEONTOLOGY

BY

G. DALLAS HANNA AND LEO GEORGE HERTLEIN

Department of Paleontology

INTRODUCTION

The expedition sent to the Gulf of California by the California Academy of Sciences in the spring of 1921 was accompanied by Dr. Fred Baker of San Diego. He collected living and fossil mollusks extensively for the Academy and the present paper is a result of a study of the fossils. We have also included those from the same region found in the collections of Leland Stanford Junior University. One species is given which was reported by Dr. Dall from the Pliocene of San Juan. Kitchen midden material, subfossils, and the species from known Pleistocene localities, are not listed in the check-list but are given under the separate localities.

* This is No. 36 of the Gulf Expedition papers.

¹A map showing all the islands, etc., visited will be found in the General Account of this Expedition by Joseph R. Slevin, these Proceedings, Vol. 12, No. 6, 1923, pp. 55-72; copies of this publication can be supplied at nominal cost.

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The check-list, admittedly incomplete, will give some indication of the fauna of the upper Pliocene found on the Gulf coast of Lower California and on some of the islands in the Gulf.

We are indebted to Dr. Baker, not only for the responsibility of making the collections and field notes but for the use we have been obliged to make of the very large collection of living mollusks he assembled; a great deal of this collection has been identified by Dr. Baker, but the results, as yet, have been published only in part. The late Mr. Eric Knight Jordan kindly determined some of the species for us. Acknowledgment is also due Prof. James Perrin Smith, of Leland Stanford Junior University for permission to study the Gulf region collections in that institution; also Mrs. Ida S. Oldroyd has given permission to study certain living shells in the conchological collection of the same institution.

Little is known concerning the detailed geology of the Gulf coast of Lower California and the fact that neither of the authors was on the expedition makes this paper chiefly a faunal study. Most of the Pliocene beds have low dips and for the most part they are made up of medium grained sandstones; at some localities the rocks are somewhat calcareous although they cannot be generally referred to as limestone. No fossils older than Pliocene were found.

REVIEW OF EARLIER WORK OF GULF REGION GEOLOGY

A German scientist Grewingk² described the geology of parts of the Gulf of California region in 1847.

In 1869, J. Ross Browne³ referred to beds near Loreto and considered them to be of Post-Pliocene age. He stated: "Half a dozen miles north of Loreto is a group of hills of Post-Pliocene age, highly fossiliferous. The largest of these, perhaps 600 feet high, is known as Cerro de los Ostiones. The fossils are in a pretty good state of preservation [and] are all living species, but the variety is not very great." Whether the

² Beitrag zur Kenntniss der Geognostischen Beschaffenheit Californiens. Verhandlungen der Russisch-Kaiserlichen Mineralog. Gesellschaft zu St. Petersburg 1847 [1848] pp. 143-162.

³ Resources of the Pacific States and Territories, 1869, p. 116.

beds referred to by Browne are of Pliocene or Pleistocene age cannot be definitely ascertained as yet. Pliocene beds, however, do occur near Loreto.

Fuchs⁴, in 1886, considered the gypsum deposits about Santa Rosalia to be of late Miocene or early Pliocene age. Dall⁵, in 1903, listed *Phacoides xantusi* Dall (formerly *P. childreni* Gray) from the "Pliocene of San Juan," Gulf of California. Arnold⁶, in 1906, described a *Pecten* and listed a few other species from Santa Rosalia, and stated that the beds were probably of Miocene age. Wittich⁷, in 1909 and 1911, referred to beds in the Cape region which appeared to him to be of Pliocene age. Pliocene, referred to the Salada, was mapped by geologists of the Marland Oil Company⁸ in 1924, over various areas along the Gulf coast of Lower California. Johnston⁹, in 1924, referred to Pliocene beds at various localities along the Gulf coast of Lower California as well as on some of the islands in the Gulf. Hertlein¹⁰, in 1925, referred to beds in the vicinity of Santa Rosalia as "Carrizo" in age following Arnold; these beds were considered to be of Pliocene age. At the same time Pliocene pectens were listed from many other localities in Lower California. Hanna¹¹, in 1926, referred to the Pliocene of San Juan as referred to by Dall. The same year, E. K. Jordan & Hertlein¹², in a discussion of the correlation of the Pliocene beds on Maria Madre Island stated: "The beds are not far removed in age from the upper Pliocene of Loreto, Santa Antonita Point, San Jose Island, and San Marcos Island, in the Gulf of California region." In a later paper in 1926 the same authors¹³ stated that the Pliocene fauna of Maria Madre Island is more closely related to the Pliocene of the Gulf of California region than to that of Cedros Island and Turtle Bay and that the Maria Madre Island fauna might be younger than the latter.

⁴ Geol. Soc. France (3), Bull. 14, 1886, p. 81.

⁵ Trans. Wag. Inst. Sci., Vol. 3, pt. 4, 1903, p. 1377.

⁶ U. S. Geol. Surv., Prof. Paper, No. 47, 1906, p. 84-85.

⁷ Bol. Soc. Geol. Mex. T. 6, 1909, p. 8; Zeit. d. Deut. Geol. Gesellschaft Monstber. Nr. 12, 1911, p. 581.

⁸ Bol. del Petroleo, Vol. 18, No. 1, 1924, opposite p. 52.

⁹ Proc. Calif. Acad. Sci., 4th Ser., Vol. 12, No. 30, 1924, pp. 951-957.

¹⁰ Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, pp. 1-35.

¹¹ Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 18, 1926, p. 475.

¹² Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 4, 1926, p. 213.

¹³ Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 14, 1926, p. 424.

CHECK-LIST OF PLIOCENE SPECIES

ECHINOIDEA

- Clypeaster testudinalis* GRAY; Santa Antonita Point, Loc. 795 (C.A.S.).
Encope grandis(?) AGASSIZ; Carmen Island, Loc. 828 (C.A.S.).

CŒLEENTERATA

- Coral; Carmen Island, Loc. 826a (C.A.S.).
 Coral; Carmen Island, Loc. 828 (C.A.S.).
 Coral; Santa Antonita Point, Loc. 795 (C.A.S.).
 Coral; Monserrate Island, Loc. 836 (C.A.S.).

PELECYPODA

- Anomalocardia subimbricata* SOWERBY; Santa Antonita Point, Loc. 795 (C.A.S.).
Antigona multicosata SOWERBY; Coronados Island, Loc. 796 (C.A.S.).
Arca grandis BRODERIP & SOWERBY; Carmen Island, Loc. 828 (C.A.S.).
Arca multicosata SOWERBY; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 826a; 798; 830 (C.A.S.); Monserrate Island, Loc. 836 (C.A.S.); Las Galeras Island, Loc. 837 (C.A.S.); Ceralbo Island, Loc. 840 (C.A.S.).
Arca pacifica SOWERBY; Santa Antonita Point, Loc. 795 (C.A.S.).
Arca reeviana ORBIGNY; Carmen Island, Locs. 798; 830 (C.A.S.).
Cardium biangulatum SOWERBY; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 828 (C.A.S.).
Cardium consors SOWERBY; Coronados Island, Loc. 796 (C.A.S.).
Chama sp.; Santa Antonita Point, Loc. 795 (C.A.S.).
Chione succincta VALENCIENNES; Santa Antonita Point, Loc. 795; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Locs. 798; 830 (C.A.S.); Pond Island, Loc. 838 (C.A.S.); Pelican Island, Loc. 841 (C.A.S.).
Codakia colpoica DALL; Santa Antonita Point, Loc. 795 (C.A.S.); Coronados Island, Loc. 796 (C.A.S.); Loreto, Locs. 797; 844 (C.A.S.); Carmen Island, Locs. 798; 830 (C.A.S.).
Cyathodonta undulata CONRAD; Santa Antonita Point, Loc. 795 (C.A.S.).
Diwaricella eburnea REEVE; Carmen Island, Loc. 828 (C.A.S.).
Glycymeris gigantea REEVE; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 798; 830 (C.A.S.).
Glycymeris multicosata SOWERBY; Santa Antonita Point, Loc. 795 (C.A.S.); Carmen Island, Loc. 830 (C.A.S.).

- Kellia* sp.; Carmen Island, Loc. 828 (C.A.S.).
- Macrocallista aurantiaca* SOWERBY; Santa Antonita Point, Loc. 795 (C.A.S.).
- Macrocallista squalida* SOWERBY; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Locs. 798; 828; 830 (C.A.S.).
- Margaritifera mazatlanica* HANLEY; Coronados Island, Loc. 796 (C.A.S.); Ceralbo Island, Loc. 840 (C.A.S.).
- Metis excavata* SOWERBY; Loreto, Loc. 797 (C.A.S.).
- Ostrea fisheri* DALL; Espiritu Santo Island, Loc. 833 (C.A.S.); Ceralbo Island, Loc. 840 (C.A.S.).
- Ostrea megodon* HANLEY; Loreto, Loc. 794 (C.A.S.); Santa Antonita Point, Loc. 795 (C.A.S.).
- Ostrea vespertina* CONRAD; Santa Antonita Point, Loc. 795 (C.A.S.); Loreto, Loc. 797 (C.A.S.); Coronados Island, Loc. 796 (C.A.S.); Pond Island, Loc. 838 (C.A.S.); San Jose Island, Loc. 839 (C.A.S.).
- Ostrea* sp.; Santa Antonita Point, Loc. 795 (C.A.S.); Loreto, Loc. 844 (C.A.S.).
- Ostrea* sp.; Carmen Island, Locs. 798; 830 (C.A.S.).
- Panope generosa* GOULD; Loreto, Loc. 797 (C.A.S.).
- Pecten (Plagioctenium) cf. abictis* JORDAN & HERTLEIN; Santa Antonita Point, Loc. 795 (C.A.S.).
- Pecten (Patinopecten) bakeri* HANNA & HERTLEIN; Loreto, Loc. 794 (C.A.S.).
- Pecten (Pecten) bösci* HANNA & HERTLEIN; Santa Antonita Point, Loc. 795 (C.A.S.); Monserrate Island, Loc. 835 (C.A.S.).
- Pecten (Plagioctenium) callidus* HERTLEIN; San Jose Island, Loc. 839 (C.A.S.).
- Pecten (Pecten) carrizoensis* ARNOLD; Santa Antonita Point, Loc. 795 (C.A.S.).
- Pecten (Pecten) cataractes* DALL; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 828 (C.A.S.).
- Pecten (Plagioctenium) circularis* SOWERBY; Loreto, Locs. 794; 797; 844; 845 (C.A.S.); Santa Antonita Point, Loc. 795; Carmen Island, Locs. 798; 830; 826a (C.A.S.); Las Galeras Island, Loc. 837 (C.A.S.); San Jose Island, Loc. 839 (C.A.S.); San Marcos Island, Loc. 149 (L.S.J.U.).
- Pecten (Chlamys) dallasi* JORDAN & HERTLEIN; Santa Antonita Point, Loc. 795 (C.A.S.).
- Pecten (Plagioctenium) deserti* CONRAD; Santa Antonita Point, Loc. 795 (C.A.S.); Carmen Island, Locs. 798; 830 (C.A.S.).
- Pecten (Plagioctenium) invalidus* HANNA; San Jose Island, Loc. 839 (C.A.S.).
- Pecten (Plagioctenium) mendenhalli* ARNOLD; Santa Antonita Point, Loc. 795 (C.A.S.).

- Pecten (Amusium) cf. mortoni* Ravenel; Santa Antonita Point, Loc. 795 (C.A.S.).
- Pecten (Pecten) refugioensis* HERTLEIN; Santa Antonita Point, Loc. 795 (C.A.S.).
- Pecten (Pecten) stearnsii* DALL; Loreto, Loc. 794 (C.A.S.); Santa Antonita Point, Loc. 795 (C.A.S.); San Jose Island, Loc. 839 (C.A.S.).
- Pecten (Lyropecten) subnodosus* SOWERBY; Loreto, Locs. 794; 844 (C.A.S.); Santa Antonita Point, Loc. 795 (C.A.S.); Coronados Island, Loc. 796 (C.A.S.).
- Pecten (Patinopecten) sp.*; Loreto, Loc. 794 (C.A.S.).
- Phacoides lampros* DALL; Carmen Island, Loc. 828 (C.A.S.).
- Phacoides nuttalli* CONRAD; Carmen Island, Loc. 828 (C.A.S.).
- Phacoides xantusi* DALL; "Pliocene of San Juan"¹⁴.
- Placunanomia cf. hannibali* JORDAN & HERTLEIN; Santa Antonita Point, Loc. 795 (C.A.S.).
- Semele flavescens* GOULD; Carmen Island, Locs. 798; 830 (C.A.S.).
- Spondylus crassisquama* LAMARCK; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 829 (C.A.S.); San Jose Island, Loc. 839 (C.A.S.).
- Spondylus sp.*; Santa Antonita Point, Loc. 795 (C.A.S.).
- Venericardia crassicosata* SOWERBY; Coronados Island, Loc. 796 (C.A.S.).

GASTROPODA

- Acteocina angustior* BAKER & HANNA; Carmen Island, Loc. 828 (C.A.S.).
- Architectonica granulata* SOWERBY; Santa Antonita Point, Loc. 795 (C.A.S.).
- Arcularia complanata* POWIS; Carmen Island, Loc. 828 (C.A.S.).
- Cancellaria obesa* SOWERBY; Coronados Island, Loc. 796 (C.A.S.).
- Cassis coarctata* SOWERBY; Monserrate Island, Loc. 836 (C.A.S.).
- Cerithium stercus-muscarum* VALENCIENNES; Carmen Island, Locs. 798; 830 (C.A.S.).
- Columbella fuscata* SOWERBY; Coronados Island, Loc. 796 (C.A.S.).
- Conus regularis* SOWERBY; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 828 (C.A.S.).
- Conus scalaris* VALENCIENNES; Carmen Island, Loc. 828 (C.A.S.).
- Crepidula sp.*; Santa Antonita Point, Loc. 795 (C.A.S.).
- Crucibulum imbricatum* SOWERBY; Coronados Island, Loc. 796 (C.A.S.).
- Crucibulum spinosum* SOWERBY; Carmen Island, Locs. 798; 830 (C.A.S.).

¹⁴ Trans. Wag. Inst. Sci., Vol. 3, pt. 4, 1903, p. 1377.

- Epitonium* sp.; Santa Antonita Point, Loc. 795 (C.A.S.).
- Fasciolaria princeps* SOWERBY; Santa Antonita Point, Loc. 795 (C.A.S.); Ceralbo Island, Loc. 840 (C.A.S.).
- Fusinus dupetithouarsii* KIENER; Santa Antonita Point, Loc. 795 (C.A.S.).
- Fusinus* sp.; Santa Antonita Point, Loc. 795 (C.A.S.).
- Hipponyx antiquatus* LINNÆUS; Santa Antonita Point, Loc. 795 (C.A.S.).
- Micraronia exanimata* (COOPER). For information regarding the occurrence of this land shell in sub-fossil condition on Monserrate and Espiritu Santo Islands see Hanna, Proc. Calif. Acad. Sci., 4th Ser., Vol. 12, No. 26, 1923, p. 505, pl. 8, figs. 11-13.
- Natica bifasciata* GRAY; Coronados Island, Loc. 796 (C.A.S.).
- Nerita bernhardi* RECLUZ; Ceralbo Island, Loc. 840 (C.A.S.).
- Oliva spicata* BOLTEN; Santa Antonita Point, Loc. 795 (C.A.S.); Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 828 (C.A.S.); Las Galeras Island, Loc. 837 (C.A.S.).
- Sthenorytis toroëense* DALL; Monserrate Island, Loc. 835 (C.A.S.).
- Strombus galeatus* SOWERBY; Santa Antonita Point, Loc. 795 (C.A.S.); Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Locs. 798; 830 (C.A.S.); Ceralbo Island, Loc. 844 (C.A.S.).
- Strombus granulatus* GRAY; Carmen Island, Locs. 798; 830 (C.A.S.).
- Strombina maculosa* SOWERBY; Carmen Island, Loc. 828 (C.A.S.).
- Terebra elata* HINDS; Carmen Island, Loc. 828 (C.A.S.).
- Terebra variegata* GRAY; Carmen Island, Loc. 828 (C.A.S.).
- Trivia sanguinea* GRAY; Carmen Island, Loc. 828 (C.A.S.).
- Turbo fluctuosus* WOOD; Carmen Island, Loc. 829 (C.A.S.).
- Turbo saxosus* WOOD; Coronados Island, Locs. 796; 798; 830 (C.A.S.).
- Turritella goniostoma* VALENCIENNES; Santa Antonita Point, Loc. 795 (C.A.S.); Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 828 (C.A.S.).

CIRRIPEDIA

- Balanus* sp.; Santa Antonita Point, Loc. 795 (C.A.S.).

SHARK TEETH

- Carcharodon* cf. *arnoldi* Jordan; Santa Antonita Point, Loc. 795 (C.A.S.).

COLLECTING STATIONS WITH FAUNAL LISTS AND FIELD NOTES

In the following list the age of each deposit is given with as much certainty as we could from a study of the fossils. These determinations, however, must be understood as being subject to change, in certain instances, when detailed stratigraphy and larger collections shall have been made. The numbers, with the exception of the first, are recorded in the locality register of the Department of Paleontology and the quotations from field notes are taken from the copy submitted by Dr. Baker immediately upon his return from the expedition.

Loc. 149 (L.S.J.U.) San Marcos Island; collection in Leland Stanford Junior University. A large deposit of gypsum on this island indicates a great change in topography of the present region occupied by the Gulf of California.

Pecten (Plagioctenium) circularis Sowerby.

Loc. 793 (C.A.S.) Marquer Bay, Carmen Island, Gulf of California; kitchen midden material; Fred Baker, coll.

Antigona multicostata Sowerby
Chama exogyra Conrad
Glycymeris gigantea Reeve

Ostrea fisheri Dall
Spondylus crassisquama Lamarck
Turbo fluctuosus Wood

Loc. 794 (C.A.S.) Arroyo de Arce, 15 miles north of Loreto, Lower California; Pliocene; "Cuesta Blanca". Fred Baker and Joseph Chamberlin, colls.; May 20, 1921; original location 1. See notes under No. 845.

Ostrea sp.
Ostrea megodon Hanley
Pecten bakeri Hanna & Hertlein,
new species

Pecten circularis Sowerby
Pecten subnodosus Sowerby
Pecten stearnsii Dall

Loc. 795 (C.A.S.). One-half mile back from shore at Santa Antonita Point, Lower California. Fred Baker, Virgil Owen, Joseph Chamberlin, Joseph R. Slevin, and Ivan Johnston, colls.; May 16, 17, 1921; Pliocene.

Dr. Baker made the following notes on this locality: "The fossils were collected along a cañon about half a mile inland and which empties near the point. We found the beds delimit-

ed to the interior by a heavy deposit of red sandstone which seemed to dip from 15° to 40° in a south-southwesterly direction (magnetic) toward a saw-toothed ridge which terminates in a peak marked 1650 feet high on the chart. I conclude that the red sandstone underlies the fossil beds, cropping out in a northeasterly direction, circling round to a point south, or west of south of the cañon entrance. The dips apparently vary at different points, the whole country having been greatly displaced when it was elevated. These overlying fossil beds may be the beginning of the extensive deposits exposed near Loreto, 35 miles to the south. At places overlying the fossil beds were enormous numbers of shells of living species of mollusks and these appear to be of kitchen midden origin." See Loc. 843.

<i>Clypeaster testudinalis</i> Gray	<i>Pecten</i> cf. <i>mortoni</i> Ravenel
Coral	<i>Pecten</i> <i>stearnsii</i> Dall
<i>Anomalocardia subimbricata</i>	<i>Pecten</i> <i>subnodosus</i> Sowerby
Sowerby	<i>Placunanomia</i> cf. <i>hannibali</i>
<i>Arca pacifica</i> Sowerby	Jordan & Hertlein
<i>Chama</i> sp.	<i>Spondylus</i> sp.
<i>Chione succincta</i> Valenciennes	<i>Architectonica granulata</i> Lamarek
<i>Codakia colpoica</i> Dall	<i>Crepidula</i> sp.
<i>Cyathodonta undulata</i> Conrad	<i>Epitonium</i> sp.
<i>Macrocallista aurantiaca</i> Sowerby	<i>Fasciolaria princeps</i> Sowerby
<i>Ostrea megodon</i> Hanley	<i>Fusinus dupetithouarsii</i> Kiener
<i>Ostrea vespertina</i> Conrad	<i>Fusinus</i> sp.
<i>Ostrea</i> sp.	<i>Hipponyx antiquatus</i> Linnæus
<i>Pecten bösci</i> Hanna & Hertlein	<i>Oliva spicata</i> Bolten
<i>Pecten carrizocensis</i> Arnold	<i>Strombus galcatus</i> Sowerby
<i>Pecten circularis</i> Sowerby	<i>Strombus granulatus</i> Sowerby
<i>Pecten dallasi</i> Jordan & Hertlein	<i>Turritella gonistoma</i> Valenciennes
<i>Pecten deserti</i> Conrad	<i>Balanus</i> sp.
<i>Pecten medenhalli</i> Arnold	<i>Carcharodon</i> cf. <i>arnoldi</i> Jordan

Loc. 796 (C.A.S.) Coronados Island, Lower California; from southwest point of Island; V. Owen, coll.; Pliocene. Mr. Owen gave Dr. Baker the following notes of the discovery: "The whole southwesterly end of the island appears to be fossil-bearing, sedimentary rocks, the maximum exposed thickness being 40-50 feet. The layers lie flat or dip very slightly toward the southwest point of the island."

<i>Antigona multicosata</i> Sowerby	<i>Pecten subnodosus</i> Sowerby
<i>Arca multicosata</i> Sowerby	<i>Spondylus crassisquama</i> Lamarck
<i>Cardium biangulatum</i> Sowerby	<i>Venericardia crassicosata</i> Sowerby
<i>Cardium consors</i> Sowerby	<i>Cancellaria obesa</i> Sowerby
<i>Chama exogyra</i> Conrad	<i>Columbella fuscata</i> Sowerby
<i>Chione succincta</i> Valenciennes	<i>Conus regularis</i> Sowerby
<i>Codakia colpoica</i> Dall	<i>Crucibulum imbricatum</i> Sowerby
<i>Glycymeris gigantea</i> Reeve	<i>Natica bifasciata</i> Gray
<i>Macrocallista squalida</i> Sowerby	<i>Oliva spicata</i> Bolten
<i>Margaritifera mazatlanica</i> Hanley	<i>Strombus galeatus</i> Sowerby
<i>Ostrea vespertina</i> Conrad	<i>Turritella goniostoma</i> Valenciennes
<i>Pecten cataractes</i> Dall	<i>Turbo saxosus</i> Wood

Loc. 797 (C.A.S.) East side of outlet of Arroyo de Gua into costal plain 10 miles north of Loreto, Lower California; original No. 4, May 20, 1921; Fred Baker and J. C. Chamberlin, colls.; Pliocene. See under Loc. 845 for further notes about this locality.

<i>Codakia colpoica</i> Dall	<i>Panope generosa</i> Gould
<i>Melis excavata</i> Sowerby	<i>Pecten circularis</i> Sowerby
<i>Ostrea vespertina</i> Conrad	

Loc. 798 (C.A.S.). (See under Loc. 830 C.A.S.)

Loc. 826a. Marquer Bay, Carmen Island, Gulf of California; Fred Baker, coll.; Pliocene. (See under 828 for field notes.) Three species only were found. The coral which formed an extensive reef has not been identified. The other two were:

<i>Arca multicosata</i> Sowerby	<i>Pecten circularis</i> Sowerby
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Loc. 828 (C.A.S.) Marquer Bay, Carmen Island, Gulf of California; first location near south point of Bay; Pliocene.

Dr. Baker made the following notes on the occurrence of fossils at Marquer Bay: "There are at least five distinct exposures, all evidently the same layer as the yellow bluff exposed at Bellandra Bay and of identical character but they are not eroded above so that the entire formation is in evidence. The lowest exposed rocks are non-fossiliferous, hard, conglomerates followed by 40 to 50 feet of yellow sandy material, with a coral base and mixed with other classes of fossils, pec-

tens predominating. Above this, the layer of almost pure coral showing in large masses is overlaid by a darker layer, three to six feet thick containing little evidence of coral but a larger percentage of mollusks, chiefly pectens. One exposure is continuous for half a mile.

"Messrs. Johnston and Chamberlin crossed this island and reported a similar condition at the end of the next arroyo north of Arroyo Blanco, except that the strata contained a large number of species of small shells."

Encope grandis(?) AGASSIZ, specimens are smaller and more circular in form than the one from Cedros Island figured by Israelsky.

Coral	<i>Acteocina angustior</i> Baker & Hanna
<i>Arca grandis</i> Broderip & Sowerby	<i>Arcularia complanata</i> Powis
<i>Cardium biangulatum</i> Sowerby	<i>Conus regularis</i> Sowerby
<i>Divaricella eburnea</i> Reeve	<i>Conus scalaris</i> Valenciennes
<i>Kellia</i> sp.	<i>Oliva spicata</i> Bolten
<i>Macrocallista squalida</i> Sowerby	<i>Strombina maculosa</i> Sowerby
<i>Pecten cataractes</i> Dall	<i>Terebra elata</i> Hinds
<i>Pecten circularis</i> Sowerby	<i>Terebra variegata</i> Gray
<i>Phacoides lampros</i> Dall	<i>Turritella goniostroma</i> Valenciennes
<i>Phacoides nuttalli</i> Conrad	<i>Trivia sanguinea</i> Gray

Loc. 829 (C.A.S.) On south side of Bellandra Bay, Carmen Island, Gulf of California, May 21, 1921; Fred Baker, coll.; kitchen midden material.

<i>Antigona multicostata</i> Sowerby	<i>Spondylus crassisquama</i> Lamarck
<i>Chama exogyra</i> Conrad	<i>Turbo fluctuosus</i> Wood
<i>Ostrea fisheri</i> Dall	

Loc. 830 (C.A.S.) Locations 1 and 2 on south side of Bellandra Bay, Carmen Island, Gulf of California; Fred Baker, coll.; May 22, 1921; Pliocene.

Dr. Baker made the following notes on these localities: "I took fossils from two points (Loc. 1, 2) on the south side of the bay. No. 1 is below the notch beside the conspicuous conical peak. No. 2 is a yellow bluff which can be seen from Loreto and is about 200 yards east of No. 1. The outcrop at No. 1 is very limited but at No. 2 there is a rather remarkable ridge breaking off in a yellow bluff 40 feet high and 150 to 200 feet along the bay side. The upper part of this face is a

deep coral reef, the lower portion being made up largely of shells with some corals. Pectens are relatively scarce. The coral masses are very large, some of them measuring nearly a foot across at the base and 18 to 24 inches high. They are very soft and I was unable to secure satisfactory specimens but the shells are in very good condition indeed. On both sides of this yellow bluff are exposures of a porphyritic rock."

Arca multicosata Sowerby

Arca reeviana Orbigny

Chione succincta Valenciennes

Codakia colpoica Dall

Glycymeris gigantea Sowerby

Glycymeris multicosata Sowerby

Macrocallista squalida Sowerby

Ostrea sp.

Pecten circularis Sowerby

Pecten deserti Conrad

Semele flavescens Gould

Cerithium stercus-muscarum

Valenciennes

Crucibulum spinosum Sowerby

Strombus galeatus Sowerby

Strombus granulatus Gray

Turbo saxosus Wood

Loc. 833 (C.A.S.) San Gabriel Bay, Espiritu Santo Island, Gulf of California; Fred Baker, coll.; apparently Pliocene.

Dr. Baker was unable to collect any definitely identifiable fossils from this place but he made the following note regarding the occurrence: "Just at the end of the sand beach is a stratum of black rock extending from below water to about four feet above. It looked like vesicular volcanic rock but much to my surprise I found it containing a few fossils, *Ostrea*, *Strombus*, *Pecten*. The same layer seems to extend along the beach for a mile or more."

Loc. 835. Monserrate Island, Location 1, Gulf of California; Pliocene.

Pecten bösei Hanna & Hertlein

Sthenorytis toroëuse Dall

Loc. 836 (C.A.S.) Monserrate Island, Gulf of California; Joseph R. Slevin, coll.; May 25, 1921; probably Pliocene. Mr. Slevin states that this exposure was found high up in the hills on the north end of the island and opposite Las Galeras Island.

Coral

Arca multicosata Sowerby

Cassis coarctata Sowerby

Loc. 837 (C.A.S.) Las Galeras Island, Gulf of California; four miles north of Monserrate Island; Pliocene. The speci-

mens are preserved in a coarse sandstone poorly cemented with lime. Mr. J. C. Chamberlin who made the collection reported the island to be sedimentary and the upper layer containing extensive deposits of fossils.

Arca multicosata Sowerby
Pecten circularis Sowerby

Oliva spicata Bolten

Loc. 838 (C.A.S.) Pond Island. Float said to be from fossiliferous deposit but possibly in part from a kitchen midden; V. Owen, coll.; June 30, 1921; Pliocene, at least in part. The fossils were found back in the hills and were said to be abundant. It seems unlikely that there would be extensive kitchen midden deposits very far removed from the shore.

Chione succincta Valenciennes

Ostrea vespertina Conrad

Loc. 839 (C.A.S.) San Jose Island, Gulf of California; West Anchorage, Fred Baker, coll.; May 28, 1921; Pliocene. Mr. Slevin reports that the higher parts of this island contain extensive fossil deposits.

Ostrea vespertina Conrad
Ostrea sp.
Pecten callidus Hertlein
Pecten circularis Sowerby

Pecten invalidus Hanna
Pecten stearnsii Dall
Spondylus crassisquama Lamarek

Loc. 840 (C.A.S.) First and second anchorages, Ceralbo Island; Gulf of California, June 6, 7, 1921; Fred Baker, coll.; Pliocene.

Dr. Baker made the following field notes regarding the occurrence of fossils on this island: "The first anchorage was at a long sand beach extending to a point southeasterly and known locally as 'Punta Arena'. South of this point are some yellowish sedimentary cliffs rising to a height of about 40 feet. There are several thin fossiliferous layers with coral predominating but I believe the entire formation contains some fossils.

"A few miles farther north the second anchorage was made in front of the Ruffo Ranch. On the north side of the ranch house cañon there is a conspicuous exposure of yellow fossilif-

erous sandstone. One upper layer which is blackened on exposure contains fossils in largest number. The strata are, in the main, horizontal but in one place they dip 30° possibly due to slippage."

<i>Arca multcostata</i> Sowerby	<i>Natica</i> sp.
<i>Margaritifera mazatlanica</i> Hanley	<i>Nerita bernhardi</i> Recluz
<i>Ostrea fisheri</i> Dall	<i>Strombus galeatus</i> Sowerby
<i>Fasciolaria princeps</i> Sowerby	

Loc. 841 (C.A.S.) Pelican Island, Gulf of California; May 5, 1921; kitchen midden material possibly; Fred Baker, coll.

Chione succincta Valenciennes.

Loc. 843 (C.A.S.) Santa Antonita Point, Lower California; kitchen midden(?) material, collected by Fred Baker, May 17, 1921.

The following well preserved species were found at this locality and since all are such as might be found suitable for food for Indians, the theory that the deposit is a kitchen midden is probably correct.

<i>Arca reeviana</i> Orbigny	<i>Pecten circularis</i> Sowerby
<i>Chama pellucida</i> Broderip	<i>Pecten subnodosus</i> Sowerby
<i>Dosinia ponderosa</i> Gray	<i>Tivela trigona</i> Reeve
<i>Ostrea fisheri</i> Dall	<i>Fasciolaria princeps</i> Sowerby
<i>Ostrea</i> sp.	<i>Turbo saxosus</i> Wood

Loc. 844 (C.A.S.) Location 2, about 10½ miles north of Loreto, Lower California; in Arroyo de Gua; Pliocene. The shells were preserved in a hard, cemented, coarse sandstone with many fragments of the species recorded below. See under No. 845 for further notes about this locality.

<i>Codakia colpoica</i> Dall	<i>Pecten circularis</i> Sowerby
<i>Ostrea</i> sp.	<i>Pecten subnodosus</i> Sowerby

Loc. 845 (C.A.S.) Location 3, Loreto, Lower California; Pliocene. *Pecten circularis* Sowerby, abundant in a coarse cemented sand with shell fragments.

Dr. Baker made the following notes regarding the occurrence of fossils near Loreto. See also Nos. 794, 797, and 844.

"We rode about 15 miles nearly due north of Loreto, the first 10 miles being over the coastal plain. We then entered the Arroyo de Gua, a box cañon, and almost at once saw fossils on both sides.

"We rode about three miles up the Arroyo de Gua where we crossed a steep divide into Arroyo de Arce and finally climbed a very steep divide of white rock to get over a point in the bend of the arroyo. This mass of white rock nearly all contained fossils and is called 'Cuesta Blanca' locally. The Arroyo de Arce heads near this point and the road to Mulege passes over the divide and to the north.

"The last bit of road that I travelled, cut through a light yellowish bluff fully forty feet high and filled with fossils. To the west the bluff rose much higher and was topped by a thick layer of black rock dipping sharply (about 40°) to the north. This black rock is broken away at various places down the Arroyo de Arce and seems always to contain fossils.

"There seems to be much irregular turning of strata throughout the whole region in which cliffs 100 to 200 feet high are common. A short distance below Cuesta Blanca the strata were nearly level, followed further down by a strong southerly dip. A couple of miles south the layers rose and again dipped to the southeast near the end of the district. This indicated two anticlinal folds between Cuesta Blanca and my location 4 on the east side of the Arroyo de Gua at its exit to the coastal plain.

"We found it impossible to locate and follow definite strata about Cuesta Blanca and collected as of Loc. 1 (Loc. 794 C.A.S.) for about 200 yards down the narrowly washed out cañon.

"About four and a half miles down from Cuesta Blanca and in Arroyo de Gua we found a ledge dipping from the west side toward the trail; this ledge was densely packed with fossils, chiefly pectens. This was noted as Loc. 2 (Loc. 797 C.A.S.).

"Loc. 3 (Loc. 844 C.A.S.) was about one-fourth mile farther down the same side of Arroyo de Gua.

"Loc. 4 (Loc. 845 C.A.S.) was just at the outlet from Arroyo de Gua to the coastal plain. Here a fossil bearing ridge forms a bluff overhanging the trail and from this face a large block weighing not less than 30 tons had recently fallen, crushing one side when it struck. From this debris we picked a considerable number of fossils, the most striking being huge internal casts of *Panope*.

"Our guide told us that on a course more to the east and at a distance of about 25 miles, on the road to San Bruno, there were much more extensive and richer deposits of fossils. Apparently starting from the same ridge as the Cuesta Blanca and easterly from the Arroyo de Arce, a range of hills extends southeasterly to quite near the Gulf. It is sawtoothed, the highest peak being near the southerly end. The San Bruno deposits should be in, or just north of this range."

CORRELATION

A study of the foregoing faunal lists is conclusive that sediments of upper Pliocene age are present at various points along the Gulf coast of Lower California and on some of the islands in the Gulf. The collections numbered 793, 829 and 843 (C.A.S.), are thought to be Post-Pliocene in age. Whether any beds of lower Pliocene age occur along the east coast of the peninsula cannot be determined from the present collection. A large number of species in the present collection live at present in the Gulf of California, but the occurrence at many localities of species which have heretofore been known to occur only in the Pliocene at other places leads the writers to the conclusion that the age of the fauna as a whole is upper Pliocene.

Apparently the Gulf-Pliocene fauna is to be correlated most closely with the Pliocene of Maria Madre Island as previously stated by Jordan & Hertlein. The following species are common to the two: *Terebratalia* sp., *Ostrea megodon* Hanley, *Ostrea vespertina* Conrad, *Pecten abietis* Jordan & Hertlein, *Pecten bakeri* Hanna & Hertlein, *Pecten circularis* Sowerby, *Pecten dallasi* Jordan & Hertlein, *Pecten invalidus* Hanna, *Pecten stearnsii* Dall, *Pecten subnodosus* Sowerby.

NOTES AND DESCRIPTIONS OF SPECIES

Clypeaster testudinarius (Gray)

Echinanthus testudinarius GRAY, Proc. Zool. Soc. Lond., 1851, p. 35, "Indian Ocean; Borneo".

Clypeaster testudinarius GRAY, Mart. Wieg. Arch., 1, 1866, p. 170, "Timor".

Echinanthus testudinarius GRAY, A. Agassiz, Mem. Mus. Comp. Zool., Pt. 3, 1873, p. 106.

Echinanthus (Clypeaster?) testudinarius GRAY, Kew, Univ. Cal. Pub. Geol., Vol. 12, No. 2, p. 59.

The original description is as follows:

"Vent beneath, a little within edge, depressed; back slightly raised, evenly convex; under surface rather concave from the edge. *Hab.* Indian Ocean; Borneo."

A. Agassiz stated that the original reference to the occurrence of this species is erroneous. He listed it from Australia, Hawaii, Japan, Red Sea and Gulf of California.

Two specimens from Loc. 795 are referred to the species rather than *C. bowersi* Weaver¹⁵, from Coyote Mountain, Imperial County, California. The latter appears to be constantly larger and more ovate in outline although there is some doubt as to the distinctness of the two species in large series. *C. testudinarius* has been considered to be the living form of the Gulf of California.

***Pecten (Patinopecten) bakeri* Hanna & Hertlein, new species**

Plate 5, figure 1

Left valve, large, subcircular, moderately convex, moderately thick; about 23 to 25 radiating square sided ribs separated by interspaces a little wider than the ribs, each rib ornamented with three small riblets, one on each shoulder and a middle riblet which is a little higher than the two other riblets; interspaces ornamented by three small riblets, the middle one usually slightly more prominent than the other two; ribs and

¹⁵ See Kew, Univ. Calif. Publ. Geol., Vol. 12, No. 2, 1920, p. 58, pl. 5, figs. 1a, 1b, pl. 6, fig. 1.

interspaces both covered by fine, fairly sharp concentric lines of growth; ears subequal, set off from beak by sharp squarish shoulders, ornamented by about eight or nine radiating riblets which are crossed by concentric incremental lines. Length approximately 150 mm.; height approximately 132 mm.; apical angle approximately 123° .

Holotype: left valve No. 1865, from Loc. 794 (C.A.S.) "Cuesta Blanca" on **Arroyo de Arce, 15 miles north of Loreto, Lower California**; *paratype*: left valve, No. 2214, same locality; Fred Baker, collector; upper Pliocene.

Pecten bakeri differs from other patinopectens by the number and arrangement of the secondary ribs, which ornament the ribs and interspaces.

This fine species is named for Dr. Fred Baker of San Diego, California, who collected the type specimen; it is one of the most striking pectens discovered in western North America in many years.

Fragments of a pecten in the collection from Loc. 937 (C.A.S.) on Maria Madre Island, which were collected by Hanna & Jordan, apparently belong to this species.

Pecten (Pecten) bösei Hanna & Hertlein, new species

Plate 5, figures 2, 3

Shell fairly large; right valve convex, ornamented by about 24 to 25 rather low, flattish-topped ribs which seldom show sulcation; interspaces narrower than ribs, flattish but slightly rounded at edges; ribs and interspaces crossed by fine concentric incremental lines; ears fairly large, subequal; anterior shows a faint byssal notch, above which the anterior ear slopes to hinge line forming an oblique angle; this ear possesses a fold near base; posterior ear slopes fairly abruptly to shell; ears set off from shell by sharp line and both ears ornamented by fine incremental lines of growth. Left valve slightly convex, ornamented by about 24 to 25 radiating, rounded ribs and

interspaces, crossed by fine concentric incremental lines; ears slope from hinge line obliquely toward margin of shell. Length of right valve 74 mm.; height, 66 mm.; apical angle, approximately 100° ; hinge length, 28 mm.

Syntypes: right valve, No. 2215 and left valve No. 2216, from Loc. 795 (C.A.S.); **cañon about half a mile inland from Santa Antonita Point, Lower California.** *Paratypes*: Nos. 2217; 2218; 2219; 2220; 2221 (C.A.S.) from same locality; Fred Baker, collector; upper Pliocene.

This species differs from *P. stearnsii* Dall and *P. diegensis* Dall in possessing much lower ribs and these are usually broader and seldom show sulcation.

This species is named for Dr. Emil Böse in recognition of his contributions to the Geology of Lower California.



PLATE 5

- Fig. 1. *Pecten bakeri* HANNA & HERTLEIN, new species. *Holotype*; No. 1865, from Loc. 794 (C.A.S.) "Cuesta Blanca" on Arroyo de Arce, 15 miles north of Loreto, Lower California; length about 150 mm.; p. 153.
- Fig. 2. *Pecten bösei* HANNA & HERTLEIN new species. *Syntype*; No. 2215, from Loc. 795 (C.A.S.) about one half mile inland from Santa Antonita Point, Lower California; length, 74 mm.; p. 154.
- Fig. 3. *Pecten bösei* HANNA & HERTLEIN new species. *Syntype*; No. 2216, from Loc. 795 (C.A.S.) about one half mile inland from Santa Antonita Point, Lower California; length, 80 mm.; p. 154.



1

2

3